

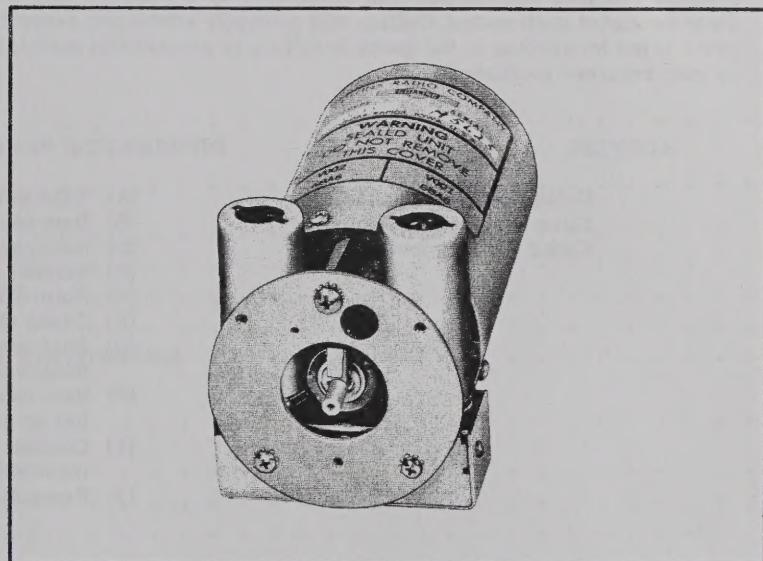
Collins

INSTRUCTION BOOK

PRECISION

TUNED OSCILLATOR

70E-15



COLLINS RADIO COMPANY

GUARANTEE

The equipment described herein is sold under the following guarantee:

Collins agrees to repair or replace, without charge, any equipment, parts, or accessories which are defective as to design, workmanship or material, and which are returned to Collins at its factory, transportation prepaid, provided

- (a) Notice of the claimed defect is given Collins within one (1) year from date of delivery and goods are returned in accordance with Collins' instructions.
- (b) Equipment, accessories, tubes, and batteries not manufactured by Collins or from Collins' designs are subject to only such adjustments as Collins may obtain from the supplier thereof.
- (c) No equipment or accessory shall be deemed to be defective if, due to exposure or excessive moisture in the atmosphere or otherwise after delivery, it shall fail to operate in a normal or proper manner.

Collins further guarantees that any radio transmitter described herein will deliver full radio frequency power output at the antenna lead when connected to a suitable load, but such guarantee shall not be construed as a guarantee of any definite coverage or range of said apparatus.

The guarantee of these paragraphs is void if equipment is altered or repaired by others than Collins or its authorized service center.

No other warranties, expressed or implied, shall be applicable to any equipment sold hereunder, and the foregoing shall constitute the Buyer's sole right and remedy under the agreements in this paragraph contained. In no event shall Collins have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

HOW TO RETURN MATERIAL OR EQUIPMENT. If, for any reason, you should wish to return material or equipment, whether under the guarantee or otherwise, you should notify us, giving full particulars including the details listed below, insofar as applicable. If the item is thought to be defective, such notice must give full information as to nature of defect and identification (including part number if possible) of part considered defective. (With respect to tubes we suggest that your adjustments can be speeded up if you give notice of defect directly to the tube manufacturer.) Upon receipt of such notice, Collins will promptly advise you respecting the return. Failure to secure our advice prior to the forwarding of the goods or failure to provide full particulars may cause unnecessary delay in handling of your returned merchandise.

ADDRESS:

INFORMATION NEEDED:

Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

- (A) Type number, name, and serial number of equipment
- (B) Date of delivery of equipment
- (C) Date placed in service
- (D) Number of hours of service
- (E) Nature of trouble
- (F) Cause of trouble if known
- (G) Part number (9 or 10 digit number) and name of part thought to be causing trouble
- (H) Item or symbol number of same obtained from parts list or schematic
- (I) Collins' number (and name) of unit sub-assemblies involved in trouble
- (J) Remarks

HOW TO ORDER REPLACEMENT PARTS. When ordering replacement parts, you should direct your order as indicated below and furnish the following information insofar as applicable. To enable us to give you better replacement service, please be sure to give us complete information.

ADDRESS:

INFORMATION NEEDED:

Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

- (A) Quantity required
- (B) Collins' part number (9 or 10 digit number) and description
- (C) Item or symbol number obtained from parts list or schematic
- (D) Collins' type number, name, and serial number of principal equipment
- (E) Unit sub-assembly number (where applicable)

INSTRUCTION BOOK

PRECISION TUNED OSCILLATOR

70E-15

520 9887 00

2nd EDITION, 15 AUGUST 1959

© **COLLINS RADIO COMPANY**
1954, 1959

CEDAR RAPIDS, IOWA, U.S.A.

PRINTED IN THE UNITED STATES OF AMERICA



TABLE OF CONTENTS

Section		Page
I	DESCRIPTION	3
II	PERFORMANCE	5
	A. General	5
	B. Calibration Linearity	5
	C. Mechanical Stability	5
	D. Reset and Backlash	5
	E. Independence from Environment	6
III	PRECAUTIONS	7
	A. Handling	7
	B. Installation	7
	C. Coupler	8
	D. Mechanical Stops	8
	E. Dial	8
	F. Power Supply	8
	G. Sealed Cover	8
IV	MAINTENANCE	11
	A. Tube Replacement	11
	B. Frequency Determination	11
	C. Resetting Endpoints	11
	D. Lubrication	12
	E. Major Servicing	12

LIST OF ILLUSTRATIONS

Figure		Page
1	Collins 70E-15 Variable Frequency Oscillator, Schematic Diagram	4
2	Collins 70E-15 VFO, Exposed View	4
3	Temperature vs Frequency (Typical Characteristics)	6
4	Voltage vs Frequency (Typical Characteristics)	7
5	Oscillator Assembly	9
6	Preliminary Temperature Compensation	9
7	Calibration Operation	10
8	Recording Instruments Used in Final Temperature Test	10
9	Outline and Mounting Dimensions Drawing	13

COLLINS 70E-15 PRECISION TUNED OSCILLATOR

CAUTION

AFTER CAREFULLY UNPACKING THE OSCILLATOR, READ THE PRE-CAUTIONS (PAGES 4 - 8) IN THIS HANDBOOK.

I. DESCRIPTION

The Collins 70E-15 (illustrated on front cover and in figure 2) is a permeability-tuned variable frequency oscillator. An idea of its size may be gained from the outline and mounting dimensions drawing, figure 9. The two shielded tubes at the front of the unit serve as oscillator and buffer; the cylindrical cover at the rear encloses components susceptible to moisture and functions as an electrical shield. Enclosed in this hermetically-sealed cover are the variable-pitch wound tuning coil and ferromagnetic core as well as a mechanical tuning corrector (figure 2). Outputs of the 70E-15 vfo are continuously variable frequencies in the range of 2.0 to

3.0 mc. Frequency is increased by rotation of the tuning shaft in a counterclockwise direction. Calibration is essentially linear. Generally the aim has been to make the unit as nearly independent of environment as possible. In the interest of stability the oscillator is temperature-compensated. As a result, stability is normally adequate over a very wide temperature range. The unit is so designed and constructed that it is nearly impervious to vibrations in the order of 5G's or less. However, in order to avoid shock in excess of the oscillator's limits, it should be handled with care.

TECHNICAL SUMMARY:

TYPE	70E-15
1. Frequency Range	2.0 - 3.0 mc
2. Calibration Linearity	±750 cycles
3. Maximum Frequency Drift 40°F to 120°F	400 cycles
4. Max. Drift with ±10% Plate Voltage Change	150 cycles
5. RF Output.	1.2 - 2.5v rms 100 mmf load
6. Plate Power.	150v @ 12 ma
7. Heater Power	6.3v @ 600 ma
8. Oven Power	none
9. Electrical Connections	solder
10. Tubes	two 6BA6
11. Shaft Size.	0.1869 - 0.1872
12. Total Shaft Rotation	10 turns
13. Rotation for Increased Frequency.	counterclockwise
14. Tuning Rate	100 kc/turn
15. Tuning Torque.	10 inch oz
16. Size	2-1/2" dia x 5"

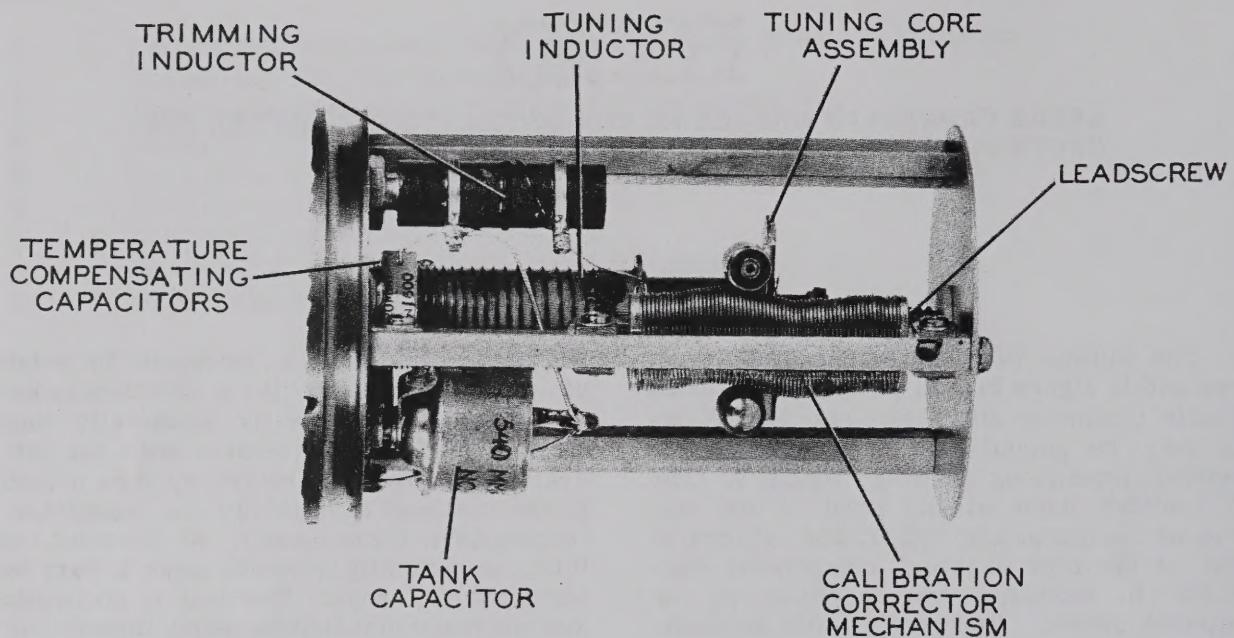


Figure 1. Collins 70E-15 Variable Frequency Oscillator,
Schematic Diagram

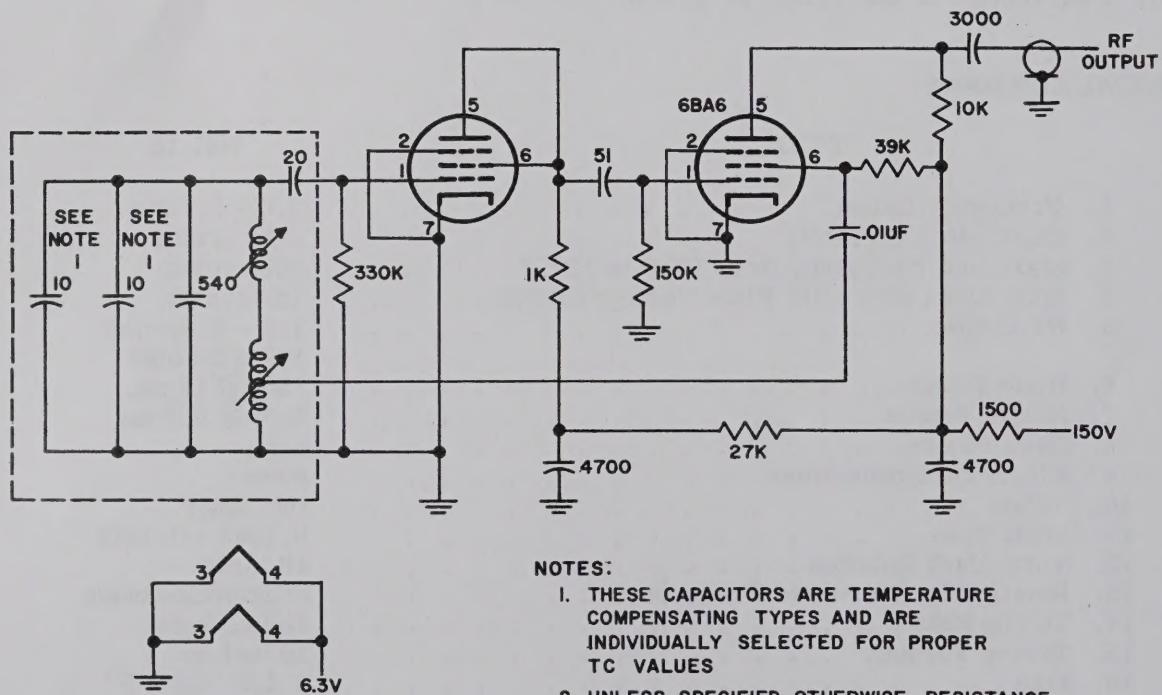


Figure 2. Collins 70E-15 VFO, Exposed View

II. PERFORMANCE

GENERAL.

The Collins 70E-15 variable frequency oscillator utilizes two type 6BA6 pentode tubes. One tube serves as a buffer which stabilizes circuit changes while reducing noise and stray line pickup because of the grounded cathode. Refer to schematic diagram, figure 1. The screen grid of the oscillator tube is used as the oscillator anode; by means of a capacitor, feedback is applied to a tap on the tuning coil. The tap is critically located to compensate tuned circuit impedance variations over the tuning range. In this way low voltage coefficients are maintained. Grid bias is obtained by means of rectification due to grid limiting action.

Oscillator output frequency is determined by the tuned tank on the left in the schematic diagram. The tank is permeability tuned by insertion of a ferromagnetic core into the main tuning coil, a variable-pitch wound inductance which is in series with a trimmer coil. Refer to figure 2, an exposed view of the 70E-15 oscillator. The capacitive branch of the parallel tank is composed of fixed capacitors in parallel, selected in part on the basis of their temperature - compensating characteristics. In this connection, see illustrations of factory test procedures, figures 6 and 8.

CALIBRATION LINEARITY.

The tuning coil of the 70E-15 oscillator has a specially developed variable-pitch winding; the tuning core is the product of a constant development program at Collins in the field of permeability tuning. In the interest of positioning accuracy, the core is loaded to a precision lead screw. The core and coil are designed to work together to produce an output frequency which is a linear function of core travel. The linearity of the frequency characteristic is perfected by adjusting a patented mechanical corrector mechanism (figure 2).

As adjustment of the internal mechanical corrector is performed (figure 7), the

oscillator is calibrated against 50 kc spectrum points which are derived from a crystal standard. The corrector controls the differential rate at which the tuning core advances into the coil as the tuning shaft is rotated. Before correction is made, the frequency calibration obtained from the variation in inductance is in the order of 0.15% linearity. Setting up a stack of washers into a cam surface within the mechanical corrector differentially adjusts the motion of the core driven by the leadscrew to a calibration linearity of plus or minus 750 cycles. Throughout the oscillator tuning range the ratio of shaft rotation to frequency change is constant.

The corrector adjustment is locked into place, insuring permanent calibration linearity. As a result, a linear dial (dial divisions of equal value equally spaced) may be used with the oscillator. An external tuning chart is not required. A trimmer inductor is provided so that frequency endpoints may be reset. Adjustment of the trimmer restores the original correspondence between the assigned travel of the leadscrew and the oscillator tuning range.

MECHANICAL STABILITY.

The 70E-15 oscillator is so designed and constructed that it is nearly impervious to vibration in the order of 5G's or less. Frequency modulation is less than 100 cps deviation under a 5G acceleration at 60 cps. Shock up to 10G's, except when applied directly to the tuning shaft, does not cause more than a few parts per million permanent frequency shift. Approximately one-half of this shift is due to the internal shifting of tube elements and the rest to oscillator component shifting.

RESET AND BACKLASH.

The ability of the oscillator to reset to the same frequency at a given angular position from the same direction of tuning shaft rotation is the measure of reset accuracy. Reset is usually more a function of dial reading than of the oscillator because the reset error of the 70E-15 is in the order of 5 parts per

million. In operation, dial and coupler backlash must be considered in the overall accuracy of reset.

Backlash error is the difference in frequency when resetting the oscillator from opposite directions of rotation to the same angular position. The backlash error on the unit is limited by design and adjustment to 50 parts or less per million. Normally this is not apparent on a dial and actually means that the frequency-determining elements are being reset mechanically to less than 0.0001 inch.

INDEPENDENCE FROM ENVIRONMENT.

Operation of the 70E-15 oscillator is essentially independent of environment. The oscillator has temperature - compensating characteristics which are finely adjusted in final test so that it produces a minimum change in frequency at from room temperature to about 70 degrees Centigrade. The oscillators are individually tested and compensated (figures 6 and 8) until uniform within very narrow limits. This process yields adequate stability over a very wide range of temperatures. The following figure shows a general curve of frequency variation vs temperature.

This graph indicates the temperature-frequency variation at both ends of the tuning range; one of the two lines being the result of a core-in condition and the other line, the result of a core-out condition. Long-term development plus rigid quality control account for a variation of frequency with temperature which is nearly the same, on a percent basis, at both ends of the range. As can be seen in the following figure, frequency variation is negligible when temperature deviations are held to a small value. Under favorable conditions, stabilities in the order of 10 to 50 parts per million are possible for operating periods of a day or so.

The 70E-15 oscillator is sealed and checked for air leakage at the factory; therefore, humidity effects are substantially eliminated. Relative humidity up to 95% will not appreciably affect short-term performance of the oscillator. Continued operation at extreme humidity may eventually cause moisture to creep past the seal, and trimmer adjustment to reset endpoint coverage may be necessary.

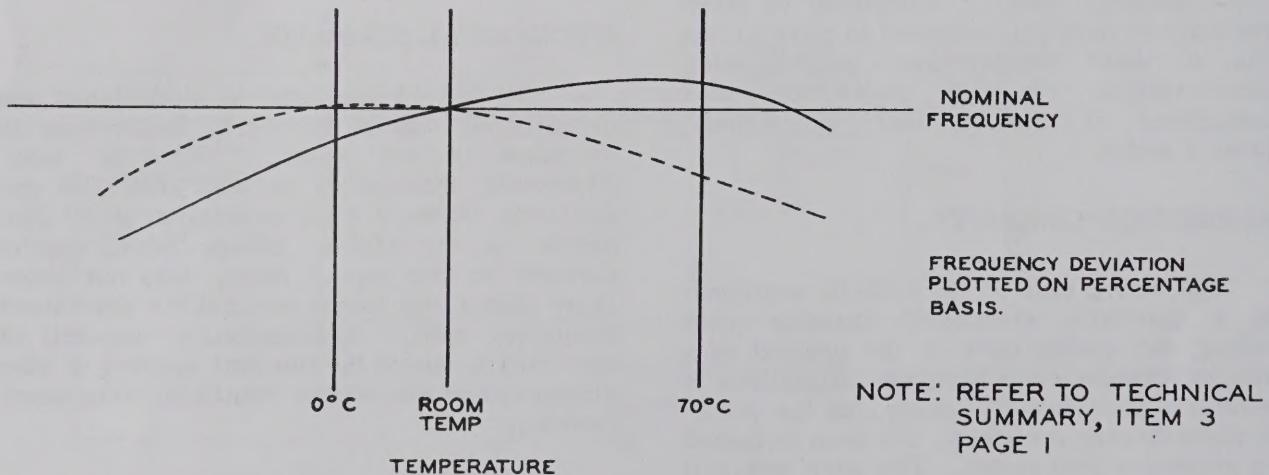


Figure 3. Temperature vs Frequency (Typical Characteristics)

Changes in plate voltage cause very small percentage changes in frequency. The following figure indicates the design center condition.

The circuit values are adjusted so that the nominal plate voltage is just above the value producing maximum flatness with a new tube. This is done in order to compensate for the aging characteristic of tubes. As the tubes

become older the point of maximum flatness moves toward higher voltage.

The following graph also illustrates the filament-frequency coefficient except that the situation is reversed. The filament coefficient is adjusted so that it falls on the low-voltage side of the flat area. This is due to the gradual movement of the flat area to a lower voltage with tube aging.

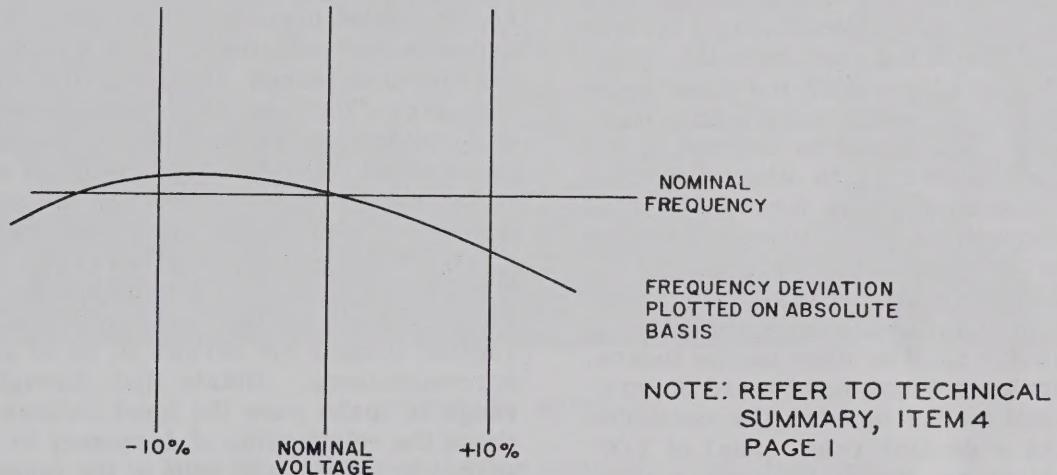


Figure 4. Voltage vs Frequency (Typical Characteristics)

III. PRECAUTIONS

HANDLING.

The Collins 70E-15 is a precision instrument and should be handled with care. Do not subject it to excessive shock.

INSTALLATION.

As an installation aid, take full advantage of the 70E-15 outline and mounting dimensions drawing, figure 9. All permeability-tuned oscillators are somewhat affected by magnetic fields. Fields from relays, power frequency reactors and other devices should be as far as practical from the oscillator. R - F fields indirectly affect the oscillator; they may be picked up on the power leads and transferred

into the unit, causing stray coupling effects and possibly frequency pulling if the field is extremely strong. The problem of coupling stray rf from the oscillator can be greatly lessened by minimizing mutual ground paths. Where this problem is encountered, the oscillator proper should be isolated from ground. Oscillator r-f leads, of course, should be kept as short as possible.

For best results, the oscillator should be located at a distance from any source of appreciable heat such as power tubes, rectifiers, etc. It is well to choose the space having the least variation in ambient temperature. Frequency stability can be degraded if such routine precautions as these are ignored.

Occasionally it may become necessary to adjust the oscillator frequency endpoints; for that reason, it is advisable to provide access to the trimmer adjustor. Allow access, too, to the mounting screws so that removal of the oscillator, in the event of maintenance, will not be difficult.

Since the oscillator leadscrew shaft has the tuning core directly loaded to it, axial movement of the tuning shaft can cause frequency deviation. The leadscrew shaft is so loaded that pressure applied toward the oscillator will tend to increase the loading and will not affect frequency appreciably. A force tending to pull the tuning shaft from the oscillator will decrease the loading and cause some shaft movement, thus shifting the frequency. The oscillator shaft should be coupled to the driving mechanism so as to eliminate axial forces and minimize radial forces. A good guide to follow is to avoid either radial or axial forces in excess of 1/2 pound or so. The unit should be mounted where it is rigidly attached to the plate or frame which contains the dial and drive shaft or other motive means. This measure goes a long way toward the prevention of axial motion between the oscillator and drive. As a general rule, metal of 1/8" minimum thickness should be used for the oscillator mounting panel.

COUPLER.

The choice of an appropriate coupler is an important one. The coupler should be a constant-velocity type that will not permit end pressure on the tuning shaft and will allow for some offset between drive shaft and lead (tuning) shaft without side loading. In addition, the coupler must be free of backlash. The Oldham coupler with a spring which loads the two outer sections to the inner section is appropriate.

MECHANICAL STOPS.

The oscillator has some mechanical overtravel beyond the specified end frequencies. The core travel is mechanically limited beyond these end frequencies; hence, care must be taken not to force the oscillator shaft beyond these limits.

CAUTION

A torque of over 20 inch-ounces should never be applied to the internal oscillator stops. It is necessary to use strong external stops on the dial drive shaft. This precaution may prevent permanent damage to frequency stability and attendant costly repairs.

DIAL.

A dial equipped with a movable index to make minor corrections in dial readings is recommended for use with the oscillator. The dial must be installed in such a way that its reading is correctly related to the oscillator frequency. In order to properly position the dial, determine oscillator frequency by means of frequency-measuring device having an error of not more than 100 cps at the oscillator fundamental. Refer to paragraphs on FREQUENCY DETERMINATION under MAINTENANCE. Rotate dial until its reading is correctly related to oscillator output. Tighten coupler set screws so as to preserve correspondence. Rotate dial throughout its range to make sure the shaft rotates freely; check the relationship of frequency to reading at the center and both ends of the range. Make adjustments if necessary.

POWER SUPPLY.

The 70E-15 is designed to remain stable in spite of primary power fluctuation normally encountered. However, to insure stability when a fluctuating primary power source is used, a voltage-regulated plate power supply in conjunction with a ballast tube 6A10, Collins part number 734 0001 00, or equivalent, in one oscillator tube filament lead is recommended. If B plus and filament sources are regulated and only small ambient temperature changes are encountered, stability of the oscillator will be very good. Average short term (24 hour) stability under these conditions is in the order of 0.003% after warmup.

SEALED COVER.

Do not remove the metal cover from the oscillator. Removal would destroy the sealed



Figure 5. Assembly

View of a portion of Collins oscillator production area.

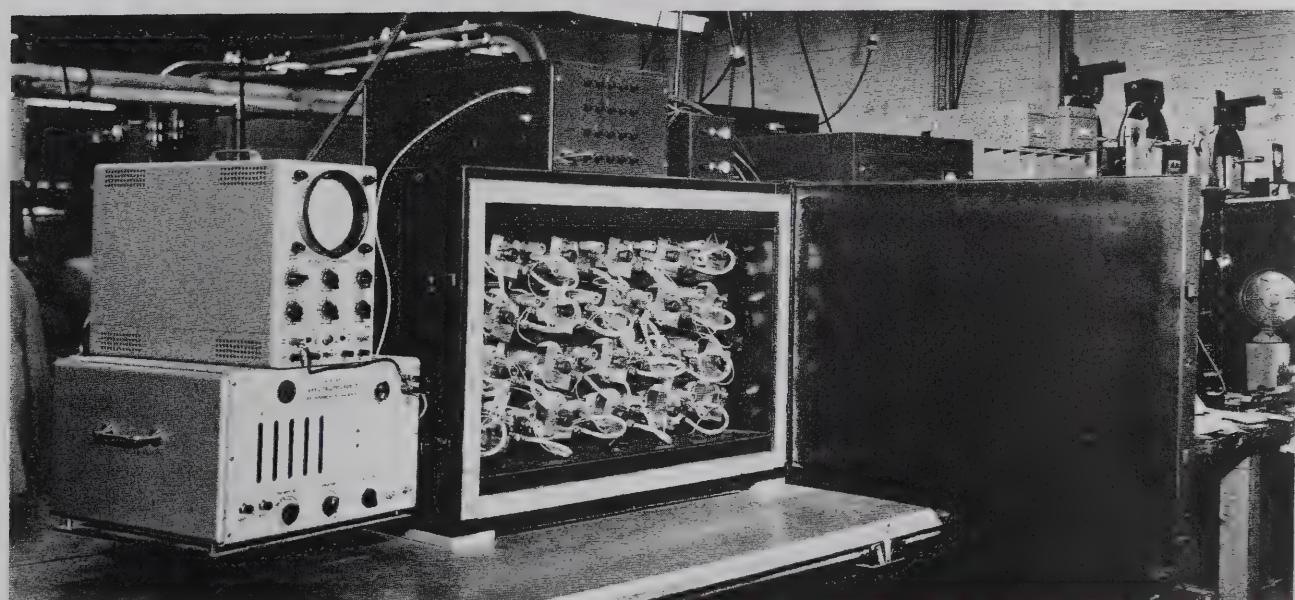


Figure 6. Preliminary Temperature Compensation

Temperature-controlled chamber and test equipment used in preliminary temperature compensation of the oscillator.

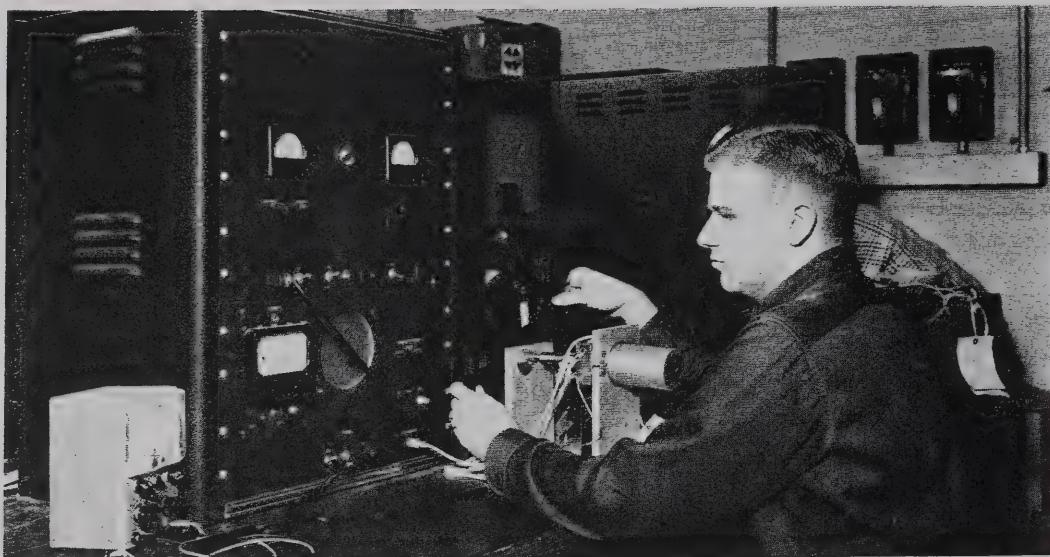


Figure 7. Calibration Operation

The oscillator is calibrated against spectrum points derived from a crystal standard. Deviation from linearity is limited by adjustment of the patented mechanical corrector.

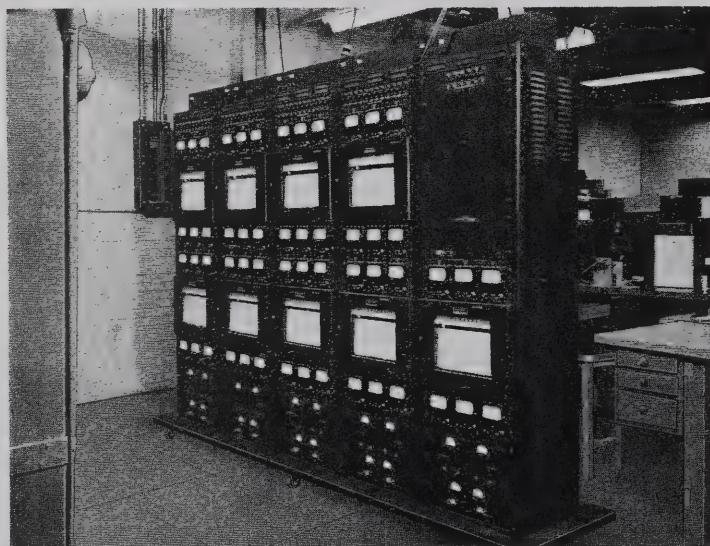


Figure 8. Recording Instruments Used in Final Temperature Test

In addition to temperature coefficient, indications are given of voltage coefficient, frequency drift, oven cycling and any erratic operation requiring correction.

Figures 5, 6, 7 and 8 relate to the assembly, calibration and test of the oscillator. The sealed cover should not be opened under any circumstances nor should the unit be tampered with. The tuning mechanism is accurately adjusted under laboratory conditions at the factory, and any attempt to perform adjustments except under these conditions would seriously affect its accuracy.

condition, subjecting the circuitry to the degrading effects of moisture. In addition, slight movement of any component in the field

of the tuning coil will destroy calibration to a degree where correction by dial-readjustment may be impossible.

IV. MAINTENANCE

TUBE REPLACEMENT.

Exhaustive tests have shown that best oscillator performance is achieved when tubes are replaced after 100 to not more than 200 days of operation. Nominal frequency drift and voltage coefficients are kept lower, affording better overall frequency stability.

FREQUENCY DETERMINATION.

In performance of many operations, such as positioning of the dial and resetting endpoints, it is necessary to determine oscillator frequencies vs. various positions of the shaft. If desired, a reliable general coverage receiver may be used to determine oscillator frequency. Either a WWV signal or a crystal calibrator may be used in conjunction with the receiver. A tabulation of convenient oscillator frequency check points, their harmonics, and corresponding WWV frequencies follows:

Oscillator Frequency (MC)	Harmonic	WWV(MC)
2.0000	5	10
2.5000	2	5
2.5000	4	10
2.5000	6	15
2.7778	9	25
3.0000	5	15

In order to determine oscillator frequency vs. shaft position, a procedure is suggested:

1. Locate the oscillator in the proximity of receiver antenna input. If necessary, connect a length of hook-up wire from oscillator r-f output to proximity of receiver input.
2. Tune the receiver to an appropriate WWV frequency.

3. Turn the oscillator on; allow sufficient warmup time.
4. Tune the appropriate oscillator harmonic to the WWV frequency. Rotate the tuning shaft until the oscillator harmonic zero-beats with WWV. In this position, oscillator harmonic frequency equals the WWV frequency.

RESETTING ENDPOINTS.

With aging of the oscillator, the tuning range will probably no longer be covered by the assigned travel of the tuning shaft. Calibration linearity can be restored and maintained for the life of the unit if endpoints are reset occasionally. In performing the operation, the following procedure is recommended.

1. For best results a frequency-measuring device having an error of not more than 100 cps at the oscillator fundamental frequency should be used. Refer to the preceding paragraphs on FREQUENCY DETERMINATION.
2. At oscillator frequency of 2.0 mc, adjust dial to read correctly.
3. Rotate oscillator tuning shaft 10 turns in counterclockwise direction. Never turn shaft with more than 20 inch ounces torque or permanent damage to calibration may result.
4. The dial should now indicate that the oscillator frequency is 3.0 mc. Subtract from this desired frequency, the actual frequency. The algebraic difference is the endpoint error.
5. To correct the endpoint error, the trimming adjustment seal plug at the front of the unit

must be removed and the trimmer screw adjusted by means of a special tool. The tool consists of two parts, Collins part numbers 540 2735 002 and 540 2736 002. Using the outer part of the special tool, loosen the lock nut that is visible when the seal plug is removed. Insert the screwdriver portion of the tool into the slotted trimmer stud and adjust trimmer for the desired frequency. Tighten lock nut, being careful not to disturb the trimmer adjustment.

6. The following formula has been derived:

Frequency shift required to correctly set endpoints by trimmer adjustment equals endpoint error $\times 1.8$.

Consider an example:

- A. Assume the frequency actually indicated in step 4 is 2.997000 mc. This gives an endpoint error equal to positive 3000 cps.
- B. Therefore, the frequency shift required equals 3000 cps $\times 1.8$ equals 5400 cps.

- C. Therefore, the trimmer should be adjusted so that the frequency actually measured (shaft still set at position turned to in step 3) is 3.002400 mc (2.997000 mc plus 5400 cps).
- D. The trimmer seal plug should be replaced as soon as possible after the above steps are performed.
- E. Position the dial properly. If the procedure has been followed the endpoint error should be nearly zero.

LUBRICATION.

The oscillator is lubricated for life and under normal conditions a unit should be capable of over 100,000 cycles of travel from one endpoint to the other without destructive wear.

MAJOR SERVICING.

If the oscillator requires major servicing it is recommended that it be returned to the factory. Although a schematic diagram (figure 1) is included, it was not provided as a troubleshooting guide but rather as information on theory of operation. For reasons already mentioned, the metal cover should not be removed from the unit.

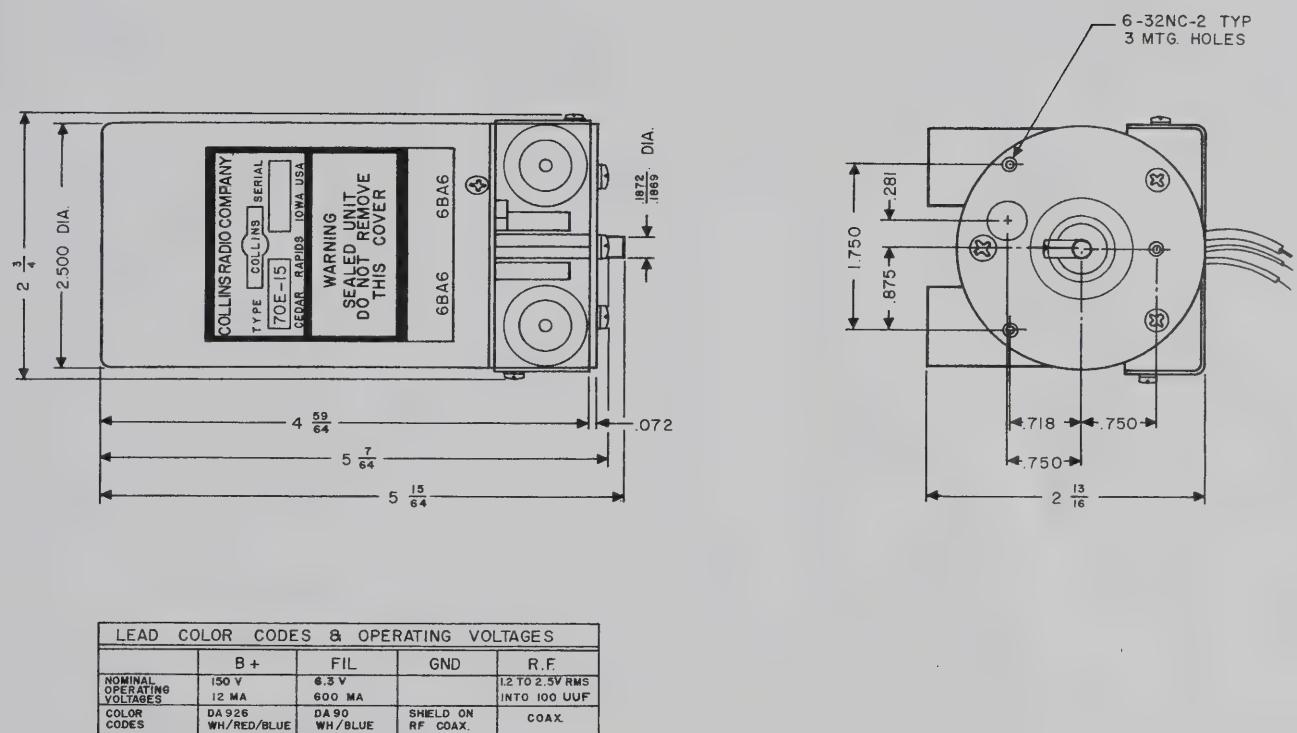


Figure 9. Outline and Mounting Dimensions Drawing

HOOK-UP WIRE CODE

The characteristics of the hook-up wire used in this equipment are indicated by groups of symbols on the diagrams. Each symbol group consists of a maximum of three letters followed by a maximum of three numerals. When three letters are used the first indicates the type of wire, the second represents the size of wire, and the third is the letter "S", used only when the wire is shielded. When two letters are used, the first and second letters indicate either the type and size of wire or the size of wire and shielding, respectively. When one letter is used it indicates the wire size only. The first numeral indicates the color of the wire body and the second and third numerals, if any, represent the colors of tracers, all numerals being in accordance with the standard EIA and MIL-W-16878 color code.

The symbols are assigned according to the following table.

TYPE OF WIRE CODE		SIZE OF WIRE CODE		COLOR CODE	
LETTER	TYPE OF WIRE	LETTER	SIZE	NUMBER OR LETTER	COLOR
A	Cotton Braid Over Plastic (Formerly AN-J-C-48)	A	#22 AWG	0	Black
B	Busbar, Round Tinned	B	#20	1	Brown
C	MIL-W-16878 Type B (#20 and Larger) (600 Volts)	C	#18	2	Red
D	Miniature Wire, MIL-W-16878 Type B (#22 and Smaller)	D	#16	3	Orange
E		E	#14	4	Yellow
F	Extra Flexible Varnished Cambric	F	#12	5	Green
G		G	#10	6	Blue
H	Kel-F (Monochlorotrifluoroethylene)	H	#8	7	Violet
J		J	#6	8	Gray (Slate)
K	Neon Sign Cable (15,000 Volts)	K	#4	9	White
L	Silicone	L	#2	a	Clear
M		M	#1	b	Tan
N	Single Conductor Stranded (Not Rubber Covered)	N	#0	c	Pink
P	Single Conductor Stranded (Rubber Covered)	P	#00	d	Maroon
Q		Q	#000	e	Light Green
R	MIL-W-16878 Type C (1000 Volts)	R	#0000	f	Light Blue
T	Teflon, MIL-W-16878 Type E (600 Volts)	T	#28		
V	MIL-W-16878 Type D (3000 Volts)	V	#26		
W	Teflon, MIL-W-16878 Type EE (1000 Volts)	W	#24		
X		X	#19		
Y		Y	#30		
Z	Acetate Yarn, Telephone Type	Z			

EXAMPLES

MIL TYPE C, #22AWG, UNSHIELDED WIRE, WHITE WITH RED AND GREEN TRACERS:

R	A	9	25	4-1/4
Type of Wire	Size of Wire	Color of Body	Color of Tracers	-- Length of Wire in Inches (Includes Stripping & Tinning)

MIL TYPE C, #16AWG, SHIELDED WIRE (SINGLE), WHITE WITH RED AND GREEN TRACERS:

R	D	S	9	25	4-1/4
Type of Wire	Size of Wire	Shielded	Color of Body	Color of Tracers	-- Length of Wire in Inches (Includes Stripping & Tinning)

MIL TYPE B, #22AWG, SHIELDED WIRE (MULTIPLE), WHITE, AND WHITE WITH RED TRACER:

D	A	S	(9)	(92)	4-1/4
Type of Wire	Size of Wire	Shielded	First Conductor	Second Conductor	-- Length of Wire in Inches (Includes Stripping & Tinning)

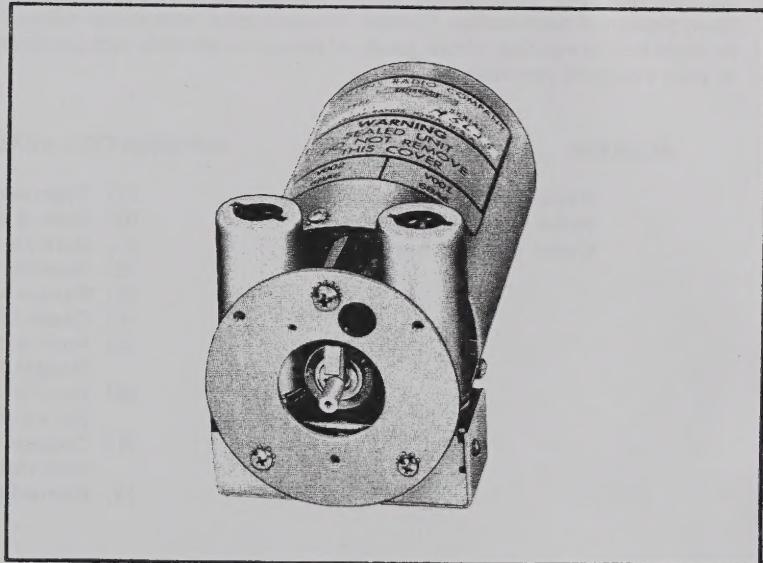


COLLINS RADIO COMPANY

Collins

INSTRUCTION BOOK

**PRECISION
TUNED OSCILLATOR
70E-15**



COLLINS RADIO COMPANY

GUARANTEE

The equipment described herein is sold under the following guarantee:

Collins agrees to repair or replace, without charge, any equipment, parts, or accessories which are defective as to design, workmanship or material, and which are returned to Collins at its factory, transportation prepaid, provided

- (a) Notice of the claimed defect is given Collins within one (1) year from date of delivery and goods are returned in accordance with Collins' instructions.
- (b) Equipment, accessories, tubes, and batteries not manufactured by Collins or from Collins' designs are subject to only such adjustments as Collins may obtain from the supplier thereof.
- (c) No equipment or accessory shall be deemed to be defective if, due to exposure or excessive moisture in the atmosphere or otherwise after delivery, it shall fail to operate in a normal or proper manner.

Collins further guarantees that any radio transmitter described herein will deliver full radio frequency power output at the antenna lead when connected to a suitable load, but such guarantee shall not be construed as a guarantee of any definite coverage or range of said apparatus.

The guarantee of these paragraphs is void if equipment is altered or repaired by others than Collins or its authorized service center.

No other warranties, expressed or implied, shall be applicable to any equipment sold hereunder, and the foregoing shall constitute the Buyer's sole right and remedy under the agreements in this paragraph contained. In no event shall Collins have any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of the products, or any inability to use them either separately or in combination with other equipment or materials, or from any other cause.

HOW TO RETURN MATERIAL OR EQUIPMENT. If, for any reason, you should wish to return material or equipment, whether under the guarantee or otherwise, you should notify us, giving full particulars including the details listed below, insofar as applicable. If the item is thought to be defective, such notice must give full information as to nature of defect and identification (including part number if possible) of part considered defective. (With respect to tubes we suggest that your adjustments can be speeded up if you give notice of defect directly to the tube manufacturer.) Upon receipt of such notice, Collins will promptly advise you respecting the return. Failure to secure our advice prior to the forwarding of the goods or failure to provide full particulars may cause unnecessary delay in handling of your returned merchandise.

ADDRESS:

INFORMATION NEEDED:

Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

- (A) Type number, name, and serial number of equipment
- (B) Date of delivery of equipment
- (C) Date placed in service
- (D) Number of hours of service
- (E) Nature of trouble
- (F) Cause of trouble if known
- (G) Part number (9 or 10 digit number) and name of part thought to be causing trouble
- (H) Item or symbol number of same obtained from parts list or schematic
- (I) Collins' number (and name) of unit sub-assemblies involved in trouble
- (J) Remarks

HOW TO ORDER REPLACEMENT PARTS. When ordering replacement parts, you should direct your order as indicated below and furnish the following information insofar as applicable. To enable us to give you better replacement service, please be sure to give us complete information.

ADDRESS:

INFORMATION NEEDED:

Collins Radio Company
Sales Service Department
Cedar Rapids, Iowa

- (A) Quantity required
- (B) Collins' part number (9 or 10 digit number) and description
- (C) Item or symbol number obtained from parts list or schematic
- (D) Collins' type number, name, and serial number of principal equipment
- (E) Unit sub-assembly number (where applicable)



COLLINS RADIO COMPANY

HOOK-UP WIRE CODE

The characteristics of the hook-up wire used in this equipment are indicated by groups of symbols on the diagrams. Each symbol group consists of a maximum of three letters followed by a maximum of three numerals. When three letters are used the first indicates the type of wire, the second represents the size of wire, and the third is the letter "S", used only when the wire is shielded. When two letters are used, the first and second letters indicate either the type and size of wire or the size of wire and shielding, respectively. When one letter is used it indicates the wire size only. The first numeral indicates the color of the wire body and the second and third numerals, if any, represent the colors of tracers, all numerals being in accordance with the standard EIA and MIL-W-16878 color code.

The symbols are assigned according to the following table.

TYPE OF WIRE CODE		SIZE OF WIRE CODE		COLOR CODE	
LETTER	TYPE OF WIRE	LETTER	SIZE	NUMBER OR LETTER	COLOR
A	Cotton Braid Over Plastic (Formerly AN-J-C-48)	A	#22 AWG	0	Black
B	Busbar, Round Tinned	B	#20	1	Brown
C	MIL-W-16878 Type B (#20 and Larger) (600 Volts)	C	#18	2	Red
D	Miniature Wire, MIL-W-16878 Type B (#22 and Smaller)	D	#16	3	Orange
E		E	#14	4	Yellow
F	Extra Flexible Varnished Cambric	F	#12	5	Green
G		G	#10	6	Blue
H	Kel-F (Monochlorotrifluoroethylene)	H	#8	7	Violet
J		J	#6	8	Gray (Slate)
K	Neon Sign Cable (15,000 Volts)	K	#4	9	White
L	Silicone	L	#2	a	Clear
M		M	#1	b	Tan
N	Single Conductor Stranded (Not Rubber Covered)	N	#0	c	Pink
P	Single Conductor Stranded (Rubber Covered)	P	#00	d	Maroon
Q		Q	#000	e	Light Green
R	MIL-W-16878 Type C (1000 Volts)	R	#0000	f	Light Blue
T	Teflon, MIL-W-16878 Type E (600 Volts)	T	#28		
V	MIL-W-16878 Type D (3000 Volts)	V	#26		
W	Teflon, MIL-W-16878 Type EE (1000 Volts)	W	#24		
X		X	#19		
Y		Y	#30		
Z	Acetate Yarn, Telephone Type	Z			

EXAMPLES

MIL TYPE C, #22AWG, UNSHIELDED WIRE, WHITE WITH RED AND GREEN TRACERS:

R	A	9	25	4-1/4
Type of Wire	Size of Wire	Color of Body	Color of Tracers --	Length of Wire in Inches (Includes Stripping & Tinning)

MIL TYPE C, #16AWG, SHIELDED WIRE (SINGLE), WHITE WITH RED AND GREEN TRACERS:

R	D	S	9	25	4-1/4
Type of Wire	Size of Wire	Shielded	Color of Body	Color of Tracers --	Length of Wire in Inches (Includes Stripping & Tinning)

MIL TYPE B, #22AWG, SHIELDED WIRE (MULTIPLE), WHITE, AND WHITE WITH RED TRACER:

D	A	S	(9)	(92)	4-1/4
Type of Wire	Size of Wire	Shielded	First Conductor	Second Conductor --	Length of Wire in Inches (Includes Stripping & Tinning)